THE SNARE OF THE RAY SPIDER (EPEIRA RADIOSA), A NEW FORM OF ORB-WEB.

By Henry C. McCook, D. D.

In the vicinity of Philadelphia, June 14, 1881, I found a number of spiders grouped not far from each other on Epeiroid webs, which proved to be of a type hitherto unknown, and which I designate as the Actinic or Ray-formed Orb-web. The spider appears also to be new to science, and is named *Epeira radiosa*.[1]

I. Character of the Web.

The first example or two of the spiders collected seemed to be upon nests that had been broken by ordinary wear and tear in

Fig. 1.—The Ray Spider seated in her snare, just before drawing the trap-line.

capturing insects; but the repetition of the form in a third snare, particularly of the peculiar open central, caused more careful examination. The result was the discovery of the remarkable

[1] *Radiosa*, full of rays. A closer study of the spider may compel the change of its generic position.

form of web here described. On account of the continually changing form of the snare, it will be necessary to present it from various points of view, and as seen in different stages of its diurnal changes.

Fig. 1 presents a view of the snare in a partially relaxed condition. The spider is seen seated in the centre of a series of rays, i, ii, iii, iv, v, which are grasped by the third and fourth pairs of legs. There is no hub, properly speaking, but the axes of the rays may be seen at times united upon a central point, as at H, fig. 2. The general tendency is to four or five main divisions or

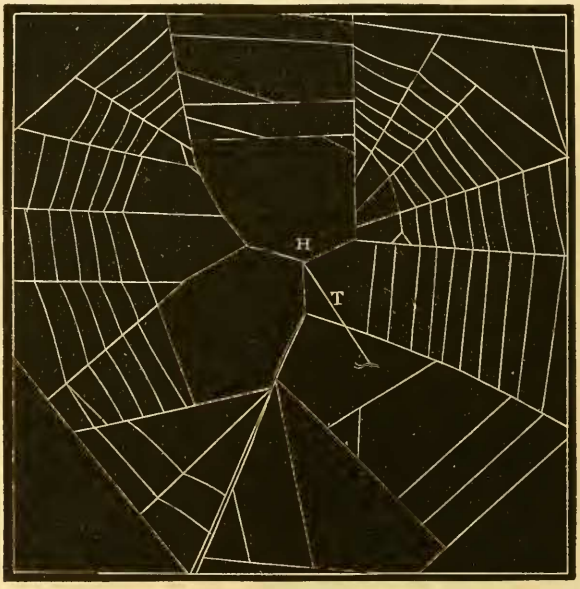


Fig. 2.

rays, as may be seen by studying the figures presented. But there is more or less variation, and in the course of the day's usage in capturing prey two sections will become interblended upon one axis, as appears to be the case in fig. 2, and also in fig. 4.

The central space is a large irregular opening, constituting about one-third of the entire snare, whose diameter is usually from three to five inches (see fig. 3). The central circle, meshes, and notched spirals which so generally characterize the Orb-webs are thus wholly wanting here.

The orb may be said to be composed of a series of independent rays or sectors, each ray composed of several spirally crossed radii, and the whole series united into an orb by cross-lines or spirals like those which unite the radii. In the shifting of the section-lines above referred to, this separation of the orb into independent rays, is always quite evident. The spirals are covered with viscid beads, as in most orb-webs The radii do not all pass to the Hub or Centre, as do those of orb-webs generally, but converge for the most part upon the axes of the rays as represented at figs. 1, 2, 3. These axes themselves converge upon a

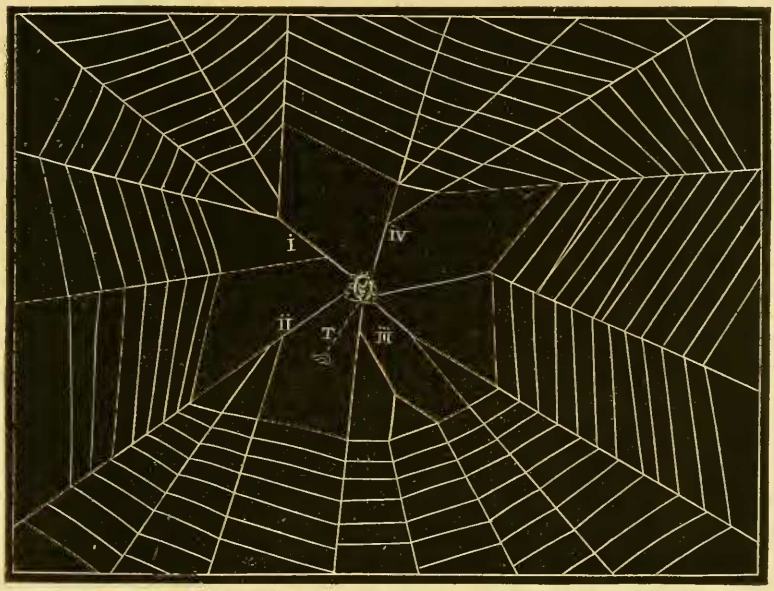


FIG. 5.—View from front. Web taut. Perspective not shown. Central opening exact.

single strong thread, a trap-line, T (figs. 1 and 2, and succeeding cuts), which is attached to some part of the surrounding surface, of rock, earth or plant. When the snare is flat or relaxed, as was the case with the one drawn at fig. 2, and as appears in fig. 1, the trap-line is often about perpendicular to the plane of the orb, as is the handle to the rays of an open Japanese umbrella. This, however, depends somewhat upon the environment; a convenient point for the attachment of the trap-line will cause the animal to divert the thread more or less from the perpendicular.

We may now suppose the spider placed as in figs. 1 and 3, at the point where the rays converge, grasping the axes with the four hind feet. The two front feet seize the trap-line and draw it taut. Then, precisely as a sailor pulls upon a rope, "hand over hand," the little arachnid's feet move along the trap-line, one over another. The axes of the rays, held firmly in the hind feet, follow her; the centre of the snare bears inward, the other parts are stretched taut, and the web at last has taken the form of a cone or funnel (figs. 4, 5). In this position the snares continually suggested to me the figure of an umbrella with ribs reversed by the wind and the covering

Fig. 4.—Side view of Ray Spider's snare, when drawn taut or bowed. Seen within a cavity.

stripped loose from the top of the handle. Fig. 4 gives a side view of the web when thus bowed or drawn taut; another snare is shown at fig. 5, as seen from behind.

In this example (fig. 5), the spider has moved quite down the trap-line to the surface of the little twig (projecting into the cavity) to which it is attached. It will thus be seen that the snare is more or less a plane surface, or more or less conical, according to the position of the animal upon the trap-line and the degree of tension thereof.

II. Mode of Operating the Snare.

When an insect strikes the snare, the spider has two modes of operating. The first somewhat resembles that of the ordinary orb-weaver in that the insect is simply permitted to entangle itself and is then taken, swathed, returned to the centre and eaten. There is, however, this difference: before going to the insect, the axes of the snare are twisted or knotted, by a rotary action of the body and movement of the legs, so that the untouched parts of the orb remains taut. Fig. 2 represents a snare thus "locked,"

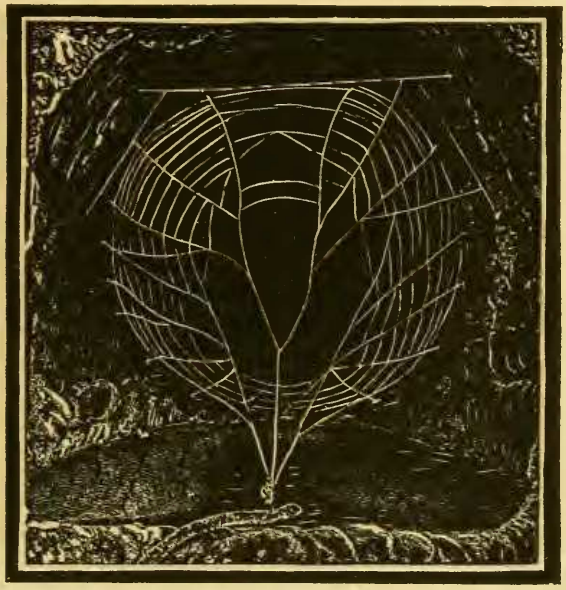


Fig. 5.

or, perhaps I might more properly say, "keyed." The trap-line is now relaxed, although its elasticity is such that the change can scarcely be noticed. The spider then moves upon her victim, quite habitually cutting out the spirals with her mandibles as she goes. When the insect is ensnared well towards the circumference of the web, and indeed, for the most part, in other cases also, it results that the ray or sector upon which the entanglement had occurred, is quite cut away. The spider thereupon proceeds to operate the remaining parts of her snare, which, in time, is thus destroyed by sections, as will be fully illustrated hereafter.

The second mode of operation resembles that of the Triangle spider, *Hyptiotes cavata*, Hentz, which has been so admirably described by Wilder, and which I have very frequently and fully observed in the suburbs of Philadelphia and throughout Pennsylvania. It is at this point that the habit of our Ray spider becomes particularly interesting. The Triangle spider makes a triangular web, which is in fact an orb sector, composed with unvarying regularity of four spirally crossed radii converging upon a single line T (fig. 6, a). Upon this line the spider hangs back downward, grasping it with all her feet, and having a portion of the line, SI (fig. 6, b), rolled up slack, between her two hind, or sometimes,

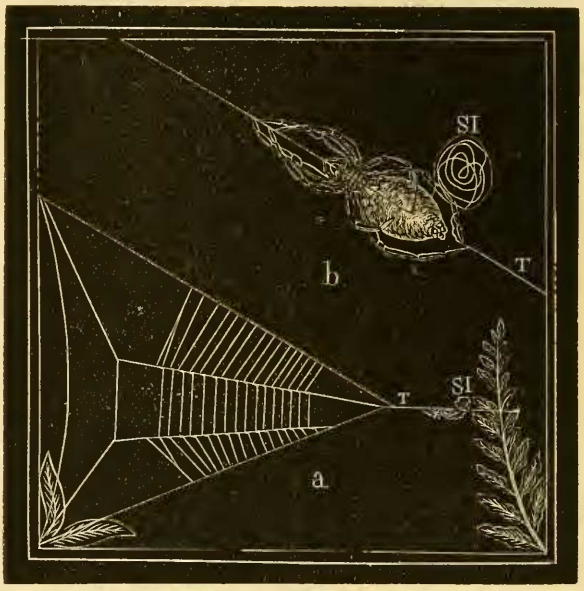


FIG. 6.—Triangle spider hanging upon taut snare. a, Spider in position. SI, Ball of slack-line. b, Enlarged figure of spider, showing the mode of grasping the line.

apparently, her fore and hind feet. Thus the forward and back parts of the trap-line are taut, while the intermediate part is slack. The spiral parts of the snare are also taut. When the web is struck by an insect, the spider suddenly releases her hind feet, the slack line sharply uncoils, the spider shoots forward, the whole web relaxes, as at fig. 7, and the spiral lines are thrown around the insect. This is repeated several times before the prey is seized.

Precisely the same action characterizes the Ray spider. Her ordinary position, or at least the one in which I most frequently observed her, is a sitting posture, back upward, as shown at fig. 1. The axes of the rays are held in the third and fourth pairs of legs, the fourth commanding the upper, the third the lower series, quite habitually, as it appeared to me. A sort of "basket," or system of connecting lines, shown at figs. 1, 9, unites all the feet, seeming to converge toward the fore-feet (perhaps, upon the second pair), where they grasp the trap-line. It is upon this foot-basket that the spider sits when her net is bowed.

This, however, is not the invariable posture; in the reconstruction of the rays and shifting of the axes, as the day's work tells

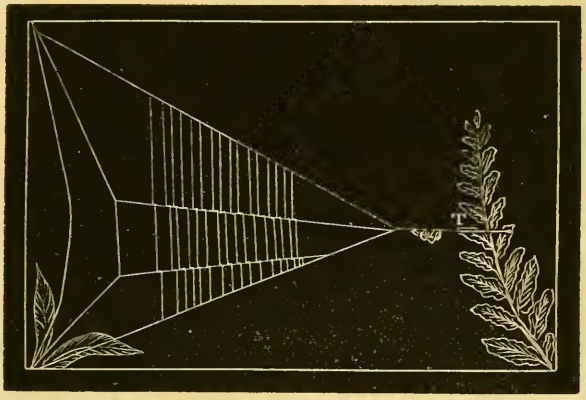


FIG. 7,—Triangle spider, *Hyptiotes cavata*, with slack-line uncoiled and snare relaxed.

upon the snare, the spider will vary her posture to that of fig. 5. The trap-line generally has a direction downward rather than upward, so that the head and fore-feet tend to be depressed below the abdomen, and this depression may gradually result in the complete inversion of the animal, fig. 5, so that she assumes the natural position of orb-weavers. I have even seen individuals with the back turned downward, fig. 8, as is the habit with the Triangle spider and with all those species who make a dome or horizontal orb-web, as the Basilica spider, *E. basilica* McCook, and the Orchard spider, *E. hortorum* Hentz.

If now the feet of the spider be carefully examined with a good glass, *a coil of slack-line* will be seen, precisely as in the case of the Triangle-spider. This is illustrated at fig. 8, where a, b, c, are the axes of several rays, grasped in the third (3) and fourth (4)

pairs of legs, and Sl is the coil or slack-line between these and the fore pairs (1 and 2), or simply between the pair of fore-legs, 1 and 2. As the spider does not exceed one-eighth of an inch in body length, and the position of the snare is within cavities and interstices of rocks, where the light does not bring out the delicate tracery of the fine webs, the observation of these and other points of like character, is a matter of some difficulty. But, although the exact relations of the coil to the feet were sometimes in doubt, and indeed seemed to vary somewhat, the existence of the coil and its general relations were determined beyond doubt. It is also certain that the slack-line sharply uncoils and straightens when the spider releases her grasp upon the trap-line, and that the web unbends and shoots quickly forward. It is instantly changed from the bowed or conical form of figs. 4 and 5 to the circular plane of figs. 1 and 2.

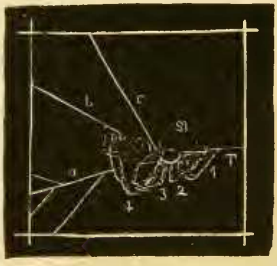


Fig. 8.—Ray spider (greatly enlarged) in position on taut snare. To show the slack-line coil, Sl.

The following points, however, long evaded my observation, before webs were found which presented the conditions for successful study. But at last I was well satisfied, although I hope for further and fuller verification during the present summer. The "springing" of the snare is caused by the sudden releasing of the trap-line from *the fore-feet*, instead of the hind-feet, as with the Triangle spider. The polarity of the two arachnids relative to their webs is reversed, Hyptiotes having her fore-feet, but Radiosa her hind-feet towards the web. The slack-line is therefore coiled between the two fore-feet or between the fore and hind-feet of Radiosa, but between the two hind pairs (as a rule) of Hyptiotes.

A glance at fig. 6, b, will suggest the manner in which Hyptiotes is affected when her two hind feet are released from the trap-line. The coil, Sl, straightens, and the whole body of the spider shoots forward. If now we turn to Radiosa, as represented at fig. 8, or again, as shown somewhat better at fig. 9, we observe that if the *fore-feet* , 1, 2, fig. 9, are released suddenly from the trap-line, T, the whole body shoots *backward*, although still toward the snare, as with Hyptiotes. This was the action which I observed.

The determination was finally accomplished by first carefully

sketching the arrangement of the basket stretched between the feet (2, 3, 3, 4, 4, fig. 9). With this chart in one hand, and in the other hand a magnifying glass focused upon the feet, I watched until favored with several successive and unsuccessful springings of the net. As the spider only leaves her seat when she thinks that an insect is well entangled, and again bows her net by pulling on the trap-line if no prey be ensnared, the above conditions enabled me to compare my chart of the basket, with the basket itself as seen under the glass. I found that the outlines on the paper and the lines under the animal's feet exactly corresponded. There had therefore been no change in the relative positions of the hind-feet, mandibles and palps, perhaps also of the second pair (2) of feet. There had been an actual (not seeming) motion of the body with and in the direction of the web, and this had been caused by releasing the first pair of legs (1) from the trap-line.

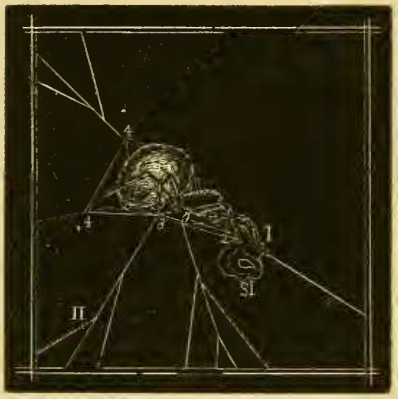


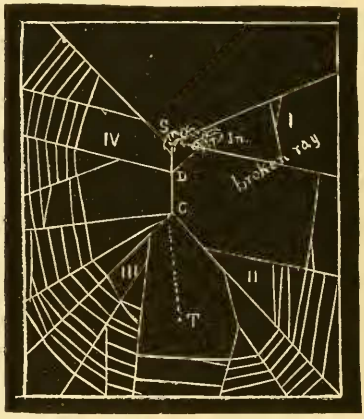
FIG. 9.—Ray spider in position showing slack coil Sl, and foot-basket, 2, 3, 4.

The importance of this determination seems greater from the fact that I had at first concluded that the Radiosa actually *operated her snare by sections*. That is, instead of springing the whole orb at once, as above described, she simply sprung *the ray struck by an insect*, by unclasping the foot holding the axis of that ray. Thus, ray ii, fig. 9, would be sprung by releasing the axis of ii, from No. 3, the third foot. This is probably not done when the snare is in complete form (as at figs. 1, 3, 4), but I now believe that it *is* done when the web has been partially destroyed, and is reduced to two rays or sectors as at fig. 11. This I hope to determine accurately during the current summer. If it should be verified we shall have another resemblance between the habits of Hyptiotes and Radiosa.

III. Gradual Obliteration of the Web.

The fragmentary condition of Radiosa's web after contact with insects has already been referred to. The snare is gradually

obliterated, a conclusion to which the spider herself very curiously contributes. When an insect strikes the snare, as at fig. 10, ray I (broken ray), Radiosa first "keys" the snare by twisting together the foot-basket and the parts adjoining (C), including the end of the trap-line. This maintains the compact condition of the snare after the spider has left the central point at which she has held all parts together in the manner heretofore described. Then the insect is sought. Creeping along the axis of the ray upon which is the entanglement, she cuts away the cross-lines as she goes, leaving the bare skeleton of radii, as shown, fig. 10, I, *broken ray*. The insect is then brought back to a point (D) near the centre, but (in this case at least,) above it, where it is eaten.



Fig, 10.—Ray spider. Action when an insect is taken. S, Spider; In, insect.

While the feast goes on, not unmindful of future supplies, the spider (S) clasps the adjoining axis and (C D) the connecting lines, which appear to be in condition for operating somewhat in the usual way. When the insect is eaten, the former position is resumed, the trap-line clasped, and the net bowed and tightened.

After a morning's trapping, if the game has been plenty, and generally towards the middle of the afternoon, Radiosa's snare will be found reduced to one or two rays or fragments of rays. I have seen it reduced to a bare skeleton. In fig. 11, there are one ray (I), and two fragments of two others united into a new ray, and these are placed in opposite parts of the orb. Again, one-half of the orb may be eliminated (fig. 12), leaving two radii (i, ii) to operate with.

Radiosa was also observed to construct or adopt a new trap-line, thus changing, so to speak, her base of operations. This action is illustrated at fig. 12, where T*a* is the original, and T*b* the new trap-line. This is not a frequent occurrence, as the necessity for changing the original line does not appear to arise frequently.

IV. The Affinities of the Actinic Orb with other Orb Webs.

Not the least interesting and valuable feature of the Ray-spider's industry, is that it discovers a connecting link between two forms of snare which stand at the very opposite poles of the spinning-work of the (Orbitelariæ) orb-weavers. At the one extreme is the familiar circular snare or full orb of the ordinary garden spider, as, for example, that of *Epeira domiciliorum*, Hentz, fig. 13. At the other is the orb-sector of the Triangle spider, figs. 6, 7. A glance at these will show how far they are apart in structure. The same separation appears in the habits of the two araneads.[1] As opposed to the Hyptiotes, the spiders of which *E. domiciliorum* is a type hang head downward in the

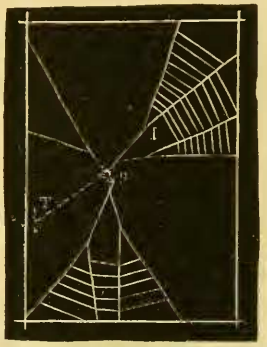


Fig. 11.—Ray spider's snare after usage in taking prey.

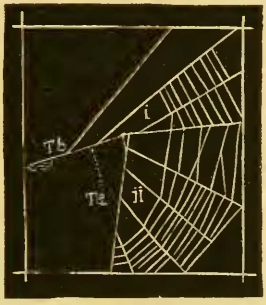


Fig. 12.—Ray spider. Half of orb eliminated and a new trap-line, Tb, formed.

centre of the orb, with their feet grasping small groups of the radii; or sit in a silken den, or crevice, holding to a taut trap-line which is connected with the centre. There is no slack coil, and no springing of the net as with the Triangle spider.

The industry of Radiosa, it is now seen, is united to that of the Full Orb makers (*E. domiciliorum, et al.*), on the one extreme, by the completeness of the circle; but with that of Hyptiotes, on the other extreme, by the independent character of the rays, the nature of the trap-line, and the entire mode of operating the snare. The facts necessary to trace their affinities I have already given.

[1] I hope that I shall be tolerated in the invention of this general word for members of the Order Araneæ; "Arachnid," the class term, is too general; "aranead" is needed for the true spiders.

Some of the striking differences I have also recorded, and they may thus be summarized. The web of Hyptiotes is a single sector; that of Radiosa has four or more, united. Hyptiotes commands one line with her feet, the trap-line and its continuation; Radiosa commands several axes, which are connected with, but not continuous of, the trap-line. Hyptiotes has her head, Radiosa her abdomen towards her snare. Hyptiotes habitually hangs to the trap-line, back downward; Radiosa generally sits upon a foot-basket of lines, back upward. Hyptiotes shoots forward when her net is sprung; Radiosa shoots backward—but both spiders move toward their webs. Hyptiotes holds her slack coil between the two hind-feet (apparently); Radiosa between the fore-feet. In these differences, the points wherein Radiosa varies from

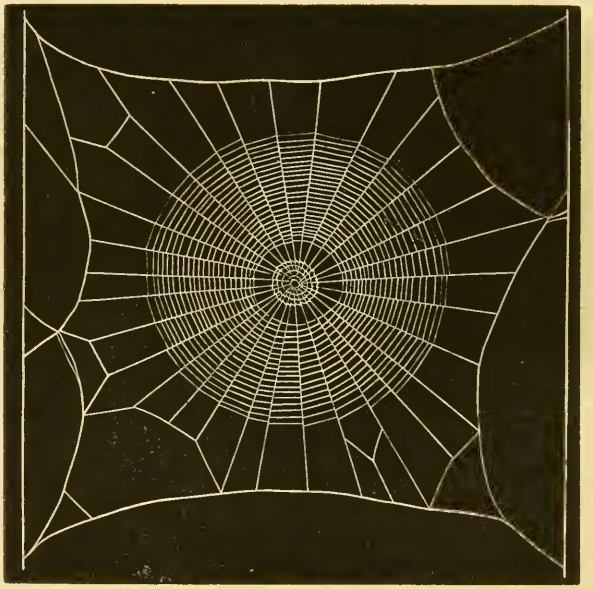


Fig. 13.—Full-Orb snare of *Epeira domiciliorum*.

Hyptiotes show a quite apparent approach to the behavior of *E. domiciliorum* and the Full-Orb makers. Thus the distance which heretofore had separated between the far-away extremes of the spinning-work of the Orbitelariæ, has been completely bridged over by the industry of our little indigenous aranead—the Ray spider. It is to be remarked that while structurally the Triangle

spider is as widely removed from the Domicile spider, as economically, the Ray spider is more closely allied structurally to the latter than the former.

V. Natural Habitat and Environment.

The first specimens of Radiosa taken were hung in large openings left between the breastwork stones of a very old mill-dam. The wall had crumbled and quite fallen away in places, leaving large cavities, within whose moist, cool shelter, among ferns and mosses, this, with several species of spiders, had domiciled. The brook poured over the middle part of the wall, making a pretty waterfall; briers, bushes, ferns and various wood plants grew out of the wall and stretched over a deep pool 12 or 15 feet in diameter, into which the fall dropped. On the lower bushes and branches above the stream, and continually agitated by the splashing of the water, was a colony of Stilt spiders, *Tetragnatha grallator*, stretching their long legs along their round webs, and dancing with the motion of the waves; the beautiful nests of *Phillyra riparia*, Hentz, nests of *Tegenaria persica*, *Lyniphia communis*, *L. neophyta*, *Epeira hortorum*, and one or two species of Theridiords, were in close neighborhood. The whole pretty scene was embowered in a grove of young trees. A more charming habitat could not well have been found.

Another colony, not far away, was established within the cavities formed underneath the roots of a large fallen tree, and beneath the ledges of some rocks over which the roots turned. In several similar positions were found the same nests, and also among the rocks in a wild ravine through which ran the stream Lownes' Run.[1]

Further explorations of the surrounding country showed that the spider was largely distributed, and in similar conditions. I found numbers in ravines, on the broad leaves of the skunk cabbage, *Symplocarpus* (or *Ichtodes*) *fœtidus*, the snares stretched over the brooklet, and beneath the shelving banks. They were also found among the rocks of Crum Creek over the beautiful drive to Howard Lewis' mill. The habitat of the Ray spider may therefore be described as moist, cool, shaded cavities and recesses among rocks, roots, beneath banks and foliage, over or near running water.

[1] Since writing the above I have found Radiosa in similar environment at Mineral-spring Glen, New Lisbon, Ohio.